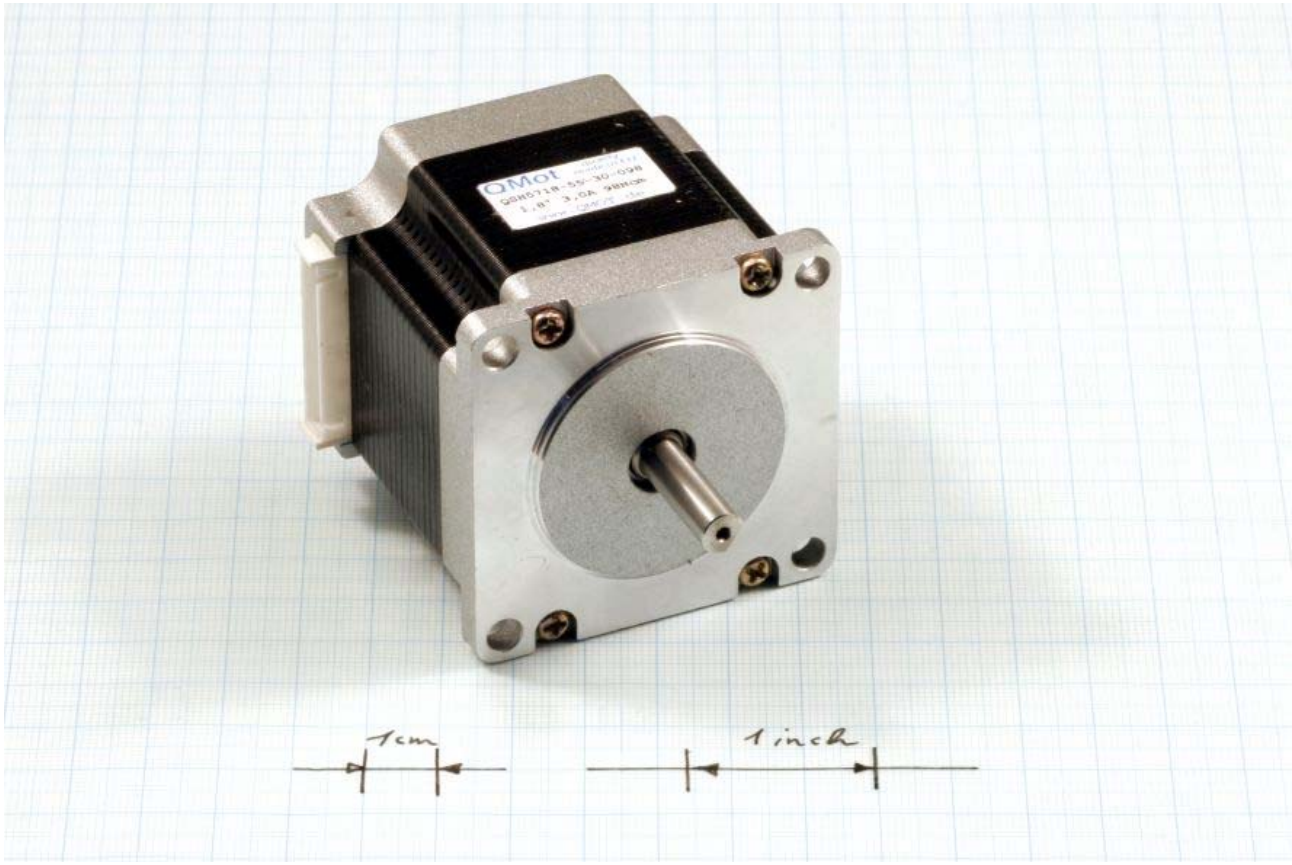
QMOT Motor QSH5718

Manual

57mm QMOT motor family



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1 Features

These two phase hybrid stepper motors are optimized for microstepping and give a good fit to the TRINAMIC family of motor controllers and drivers. They are also used in the 57mm PANdrive family.

Main characteristics:

- NEMA 23 mounting configuration
- flange max. 57.2mm * 57.2mm
- 6.35mm axis diameter, 20.6mm axis length
- step angle: 1.8°
- optimized for microstep operation
- optimum fit for TMC239 / TMC249 based driver circuits
- up to 84V operating voltage
- 4 wire connection
- neodymium magnets for maximum torque
- CE approved

Specifications	Parameter	Units	QSH5718		
			-41-30-047	-55-30-098	-79-30-163
Rated Phase Current	$I_{RMS\ RATED}$	A	3.0	3.0	3.0
Phase Resistance at 20°C	R_{COIL}	Ω	0.6	0.8	0.8
Phase Inductance (typ.)		mH	1.5	2.1	3.2
Holding Torque (typ.)		Ncm	47	98	163
		oz in	66	138	230
Detent Torque		Ncm	2.1	3.0	3.0
Rotor Inertia		g cm^2	77	209	335
Weight (Mass)		Kg	0.50	0.70	1.0
Insulation Class			B (130°C)	B (130°C)	B (130°C)
Connection Wires		N°	4	4	4
Max applicable Voltage		V	84	84	84
Step angle Accuracy		%	5	5	5
Flange Size (max.)		mm	57.2	57.2	57.2
Motor Length (max.)	L_{MAX}	mm	41.0	55.0	78.5
Axis Diameter		mm	6.35	6.35	6.35
Axis Length (typ.)		mm	20.6	20.6	20.6
Maximum Axial Axis Load		N	90	90	90
Maximum Radial Axis Load (8 mm from front flange)		N	110	110	110
Related Trinamic PANdrive		type	PD1-xxx-57	PD2-xxx-57	PD3-xxx-57

Table 1: Motor technical data

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2 Life support policy

TRINAMIC Motion Control GmbH & Co. KG does not authorize or warrant any of its products for use in life support systems, without the specific written consent of TRINAMIC Motion Control GmbH & Co. KG.

Life support systems are equipment intended to support or sustain life, and whose failure to perform, when properly used in accordance with instructions provided, can be reasonably expected to result in personal injury or death.

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Specifications subject to change without notice.

3 Mechanical Dimensions

3.1 Leadwire Configuration

Cable type 1	Cable type 2	Coil	Function
Black	Red	A	Motor coil A pin 1
Orange	Red-White	A	Motor coil A pin 2
Yellow	Brown	B	Motor coil B pin 1
Red	Brown-White	B	Motor coil B pin 2

Table 2: Leadwire configuration

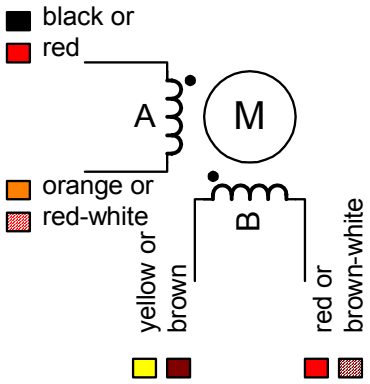

Figure 1: Leadwire configuration

3.2 Dimensions

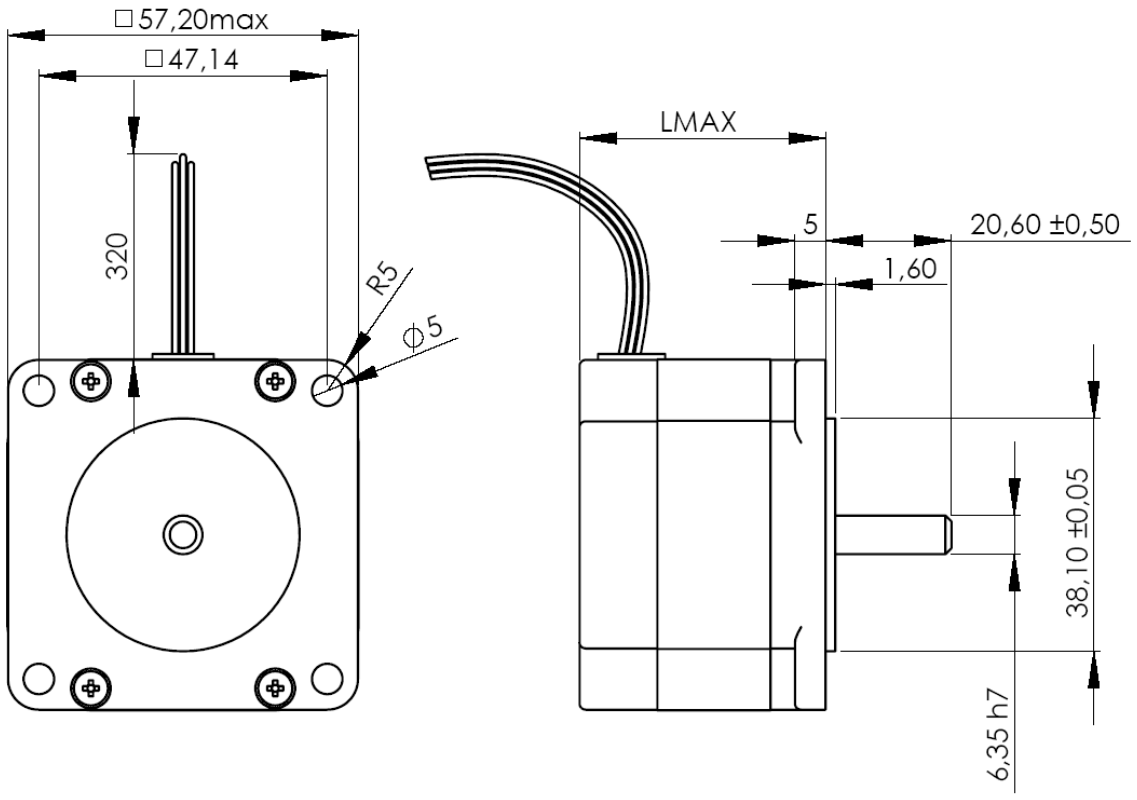

Figure 2: Dimensions (all values in mm, hx describes drilling tolerance)

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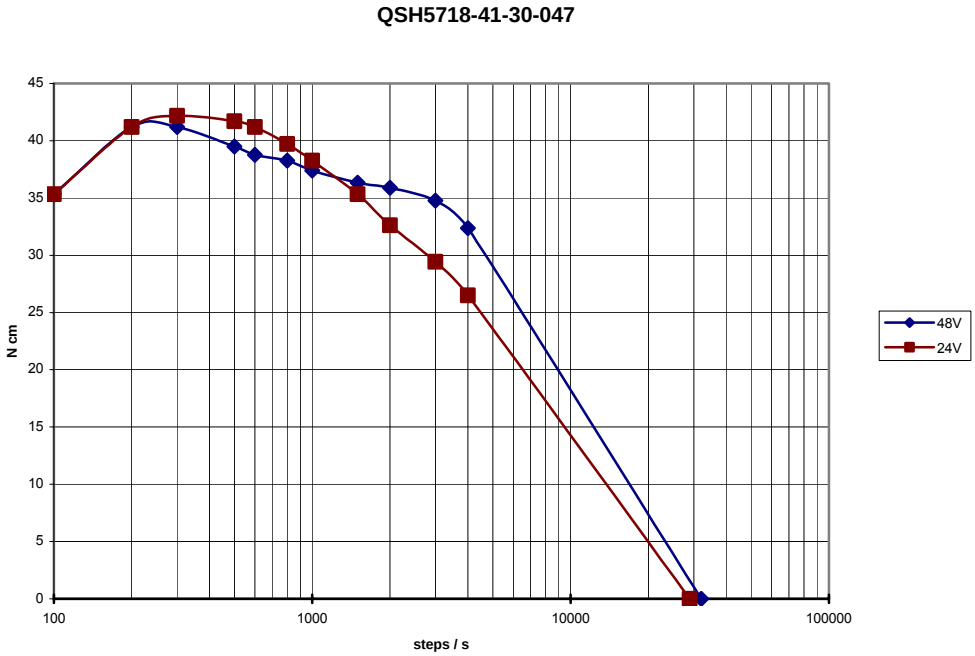
4 Torque figures

The torque figures detail motor torque characteristics for fullstep operation in order to allow simple comparison. The motors were positioned on rubber. The diagrams are based on discrete measurement points of pull-out torque (torque needed to stop rotating motor). For fullstep operation there are always a number of resonance points (with less torque) which are not depicted. These will be minimized by microstep operation in most applications.

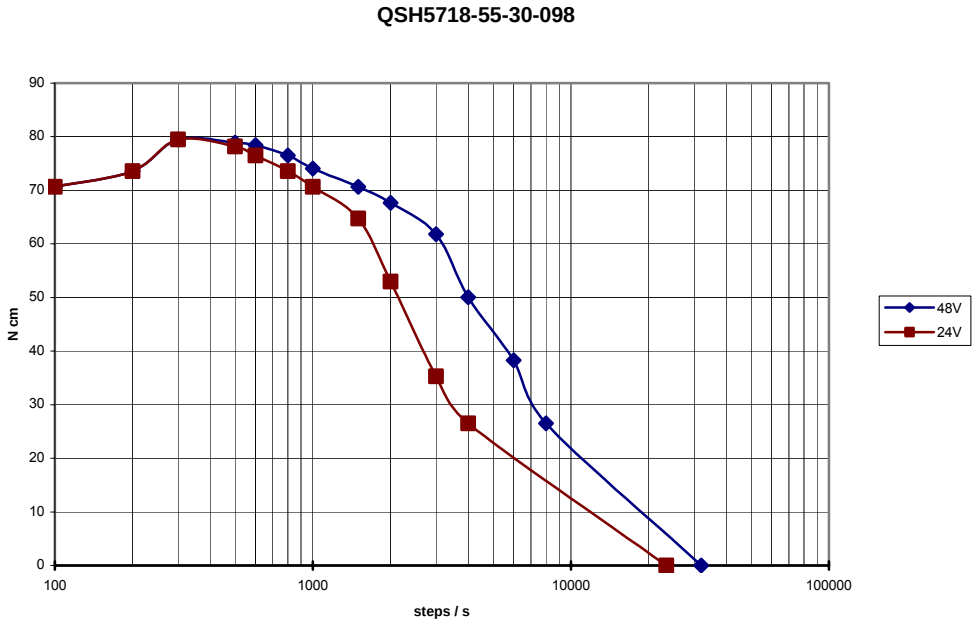
4.1 Motor QSH5718-41-30-047

Conditions: Bipolar chopper drive, 3A coil current, fullstep operation



4.2 Motor QSH5718-55-30-098

Conditions: Bipolar chopper drive, 3A coil current, fullstep operation



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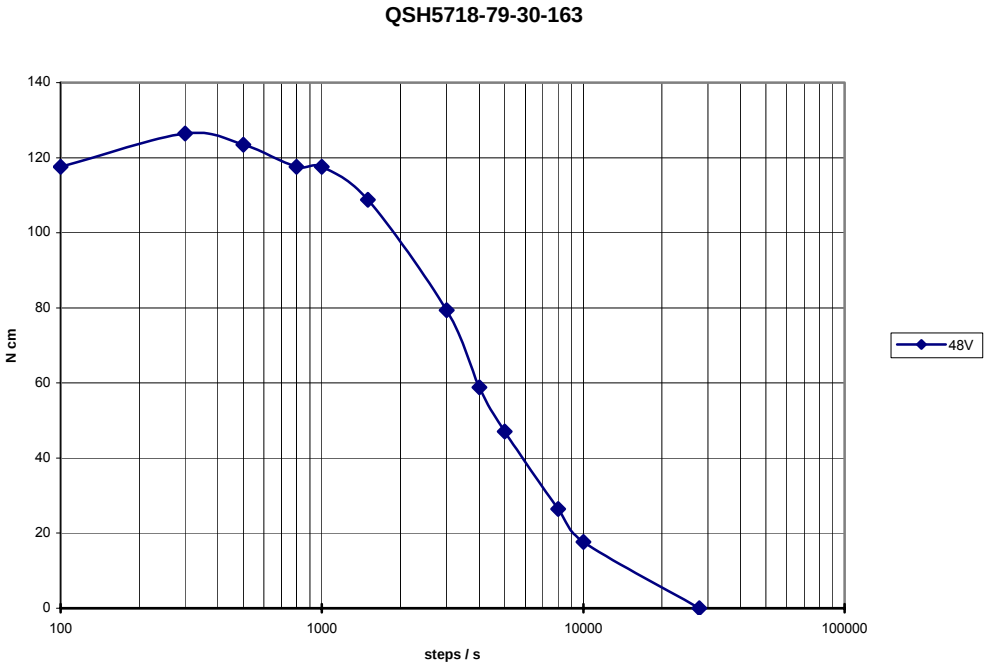
4.3 Motor QSH5718-79-30-163

Conditions: Bipolar chopper drive, 3A coil current, fullstep operation



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5 Considerations for Operation

The following chapters try to help you to correctly set the key operation parameters in order to get a stable system.

5.1 Choosing the best fitting Motor for an Application

For an optimum solution it is important to fit the motor to the application and to choose the best mode of operation. The key parameters are desired motor torque and velocity. While the motor holding torque describes the torque at stand-still, and gives a good indication for comparing different motors, it is not the key parameter for the best fitting motor. The required torque is a result of static load on the motor, dynamic loads which occur during acceleration / deceleration and loads due to friction. In most applications the load at maximum desired motor velocity is most critical, because of the reduction of motor torque at higher velocity. While the required velocity generally is well known, the required torque often is only roughly known. Generally, a longer motor and a motor with a larger diameter delivers a higher torque. But, using the same driver voltage for the motor, the larger motor earlier looses torque when increasing motor velocity. This means, that for a high torque at a high motor velocity, the smaller motor might be the better fitting solution.
Please refer to the torque vs. velocity diagram to determine the best fitting motor, which delivers enough torque at all desired velocities.

Hints:

Q: How to determine the maximum torque required by your application?

A: Just try a motor which should roughly fit. Take into consideration worst case conditions, i.e. minimum driver supply voltage and minimum driver current, maximum or minimum environment temperature (whichever is worse) and maximum friction of mechanics. Now, consider that you want to be on the safe side, and add some 10 percent safety margin to take into account for unknown degradation of mechanics and motor.

5.2 Motor Current Setting

Basically, the motor torque is proportional to the motor current, as long as the current stays at a reasonable level. At the same time, the power consumption of the motor (and driver) is proportional to the square of the motor current. Optimally, the motor should be chosen to bring the required performance at the rated motor current. For a short time, the motor current may be raised above this level in order to get increased torque, but care has to be taken in order not to exceed the maximum coil temperature of 130°C respectively a continuous motor operation temperature of 90°C.

Percentage of rated current	Percentage of motor torque	Percentage of static motor power dissipation	Comment
150%	≤150%	225%	Limit operation to a few seconds
125%	125%	156%	Operation possible for a limited time
100%	100%	100% = 2 * $I_{RMS\ RATED}$ * R_{COIL}	Normal operation
85%	85%	72%	Normal operation
75%	75%	56%	Normal operation
50%	50%	25%	Reduced microstep exactness due to torque reducing in the magnitude of detent torque
38%	38%	14%	-"-
25%	25%	6%	-"-
0%	see detent torque	0%	Motor might loose position if the application's friction is too low

Table 3: Motor current settings

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Hints:

Q: How to choose the optimum current setting?

A1: Generally, you choose the motor in order to give the desired performance at nominal current. For short time operation, you might want to increase the motor current to get a higher torque than specified for the motor. In a hot environment, you might want to work with a reduced motor current in order to reduce motor self heating.
The Trinamic drivers allow setting the motor current for up to three conditions:

- Stand still (choose a low current)
- Nominal operation (nominal current)
- High acceleration (if increased torque is required: You may choose a current above the nominal setting, but be aware, that the mean power dissipation shall not exceed the motors nominal rating)

A2: If you reach the velocity limit, it might be a good idea to reduce the motor current, in order to avoid resonances occurring. Please see the hints on choosing the driver voltage.

Q: What about energy saving – how to choose standby current?

A1: Most applications do not need much torque during motor stand-still. You should always reduce motor current during stand still. This reduces power dissipation and heat generation. Depending on your application, you typically at least can half power dissipation. There are several aspects why this is possible: In stand still, motor torque is higher than at any other velocity. Thus, you do not need the full current even with a static load! Your application might need no torque at all, but you might need to keep the exact microstep position: Try how low you can go in your application. If the microstep position exactness does not matter for the time of stand still, you might even reduce the motor current to zero, provided that there is no static load on the motor and enough friction in order to avoid complete position loss.

5.3 Motor Driver Supply Voltage

The driver supply voltage in many applications can not be chosen freely, because other components have a fixed supply voltage of e.g. 24V DC. If you have to possibility to choose the driver supply voltage, please refer to the driver data sheet, and consider that a higher voltage means a higher torque at higher velocity. The motor torque diagrams are measured for a given supply voltage. You typically can scale the velocity axis (steps / sec) proportionally to the supply voltage to adapt the curve, e.g. if the curve is measured for 48V and you consider operation at 24V, half all values on the x-Axis to get an idea of the motor performance.

For a chopper driver, consider the following corner values for the driver supply voltage (motor voltage). The table is based on the nominal motor voltage, which normally just has a theoretical background in order to determine the resistive loss in the motor.

Comment on the nominal motor voltage: $\mathbf{U_{COIL_NOM}} = I_{RMS_RATED} * R_{COIL}$
(Please refer to motor technical data table.)

Parameter	Value	Comment
Minimum driver supply voltage	$2 * U_{COIL_NOM}$	Very limited motor velocity. Only slow movement without torque reduction. Chopper noise might become audible.
Optimum driver supply voltage	$\geq 4 * U_{COIL_NOM}$ and $\leq 22 * U_{COIL_NOM}$	Choose the best fitting voltage in this range using the motor torque curve and the driver data. You can scale the torque curve proportionally to the actual driver supply voltage.
Maximum rated driver supply voltage	$25 * U_{COIL_NOM}$	When exceeding this value, the magnetic switching losses in the motor reach a relevant magnitude and the motor might get too hot at nominal current. Thus there is no benefit in further raising the voltage.

Table 4: Driver supply voltage considerations

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Hints:

Q: How to determine if the given driver voltage is sufficient?

A1: Just listen to the motor at different velocities. Does the "sound" of the motor get raucous or harsh when exceeding some velocity? Then the motor gets into a resonance area. The reason is, that the motor back-EMF voltage reaches the supply voltage. Thus, the driver can not bring the full current into the motor any more. This is typically a sign, that the motor velocity should not be further increased, because resonances and reduced current affect motor torque.

A2: Measure the motor coil current at maximum desired velocity.
For microstepping: If the waveform is still basically sinusoidal, the motor driver supply voltage is sufficient.
For Fullstepping: If the motor current still reaches a constant plateau, the driver voltage is sufficient.
If you determine, that the voltage is not sufficient, you could either increase the voltage or reduce the current (and thus torque).

5.4 Choosing the Commutation Scheme

While the motor performance curves are depicted for fullstepping, most modern drivers provide a microstepping scheme. Microstepping uses a discrete sine and a cosine wave to drive both coils of the motor, and gives a very smooth motor behaviour as well as an increased position resolution. The amplitude of the waves is 1.41 times the nominal motor current, while the RMS values equals the nominal motor current. The stepper motor does not make loud steps any more – it turns smoothly! Therefore, 16 microsteps or more are recommended for a smooth operation and the avoidance of resonances. To operate the motor at fullstepping, some considerations should be taken into account.

Driver Scheme	Resolution	Velocity range	Torque	Comments
Fullstepping	200 steps per rotation	Low to very high. Skip resonance areas in low to medium velocity range.	Full torque if dampener used, otherwise reduced torque in resonance area	Audible noise especially at low velocities
Microstepping	200 * (number of microsteps) per rotation	Low to high.	Reduced torque at very high velocity	Low noise, smooth motor behaviour
Mixed: Microstepping and fullstepping for high velocities	200 * (number of microsteps) per rotation	Low to very high.	Full torque	At high velocities, there is no audible difference for fullstepping

Table 5: Comparing microstepping and fullstepping

Microstepping gives the best performance for most applications and can be considered as state-of-the art. However, fullstepping allows some ten percent higher motor velocities, when compared to microstepping. A combination of microstepping at low and medium velocities and fullstepping at high velocities gives best performance at all velocities and is most universal. Most Trinamic driver modules support all three modes.

5.4.1 Fullstepping

When operating the motor in fullstep, resonances may occur. The resonance frequencies depend on the motor load. When the motor gets into a resonance area, it even might not turn any more! Thus you should avoid resonance frequencies.

Hints:

Q: How to avoid motor resonance in fullstep operation?

A1: Do not operate the motor at resonance velocities for extended periods of time. Use a reasonably high acceleration in order to accelerate to a resonance-free velocity. This avoids the build-up of resonances. When resonances occur at very high velocities, try reducing the current setting.

A2: A resonance dampener might be required, if the resonance frequencies can not be skipped.

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6 Revision History

6.1 Documentation Revision

Version	Comment	Description
1.00	Initial Release	
1.01	Minor change	New cable coloring scheme
1.1	Torque figures	Added missing torque figures
1.11	Axis Load	Added Axial / Radial load
1.12	Additions	

Table 6: Documentation Revisions

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